Research and Development Technical Report

ECOM-4547

LOW PROFILE ANTENNA PERFORMANCE STUDY
PART III: BIBLIOGRAPHY

C. M. DeSantis
Communications/ADP Laboratory

DEC 30

November 1977

ADA047991

DDC FILE COPY

DISTRIBUTION STATEMENT

Approved for public release;
distribution unlimited.

ECOM

US ARMY ELECTRONICS COMMAND FORT MONMOUTH, NEW JERSEY 07703

NOTICES

Disclaimers

The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

The citation of trade names and names of manufacturers in this report is not to be construed as official Government indorsement or approval of commercial products or services referenced herein.

Disposition

Destroy this report when it is no longer needed. Do not return it to the originator.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: ECOM-4547 (14)	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER: rept.	
4. TITLE (and Subtitle): Low Profile Antenna Performance Study Part III: BIBLIOGRAPHY (6)	5. TYPE OF REPORT & PERIOD COVERED: FINAL Sep[redacted]975- Mar[redacted]977 (9)
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): C.M. DeSantis (10)	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Communications/ADP Laboratory DRSEL-NL-RH Fort Monmouth, New Jersey 07703	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 6.1 1T61101A91A 32 08 (16) (17)
11. CONTROLLING OFFICE NAME AND ADDRESS: Communications/ADP Laboratory US Army Electronics Command Fort Monmouth, New Jersey 07703	12. REPORT DATE: Nov[redacted]r [redacted]977 (11)
	13. NUMBER OF PAGES: 8
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office): (12) 12p.	15. SECURITY CLASS. (of this report): UNCLASSIFIED
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Distribution Statement A: Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Small antenna bibliography
broad-band antenna summary

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report contains an extensive bibliography of information on the analysis, design, and experimentation of small antennas aimed at improving bandwidth and efficiency. The report also contains a tabular summary of the bandwidth of various small antennas which have been reported in the literature. This report forms the third part of a three part series of reports entitled, "Low-Profile Antenna Performance Study."

037620

CONTENTS

LOW-PROFILE ANTENNA PERFORMANCE STUDY

PART III: BIBLIOGRAPHY

1. REVIEW

This report contains an extensive bibliography of information on small antennas; specifically, ideas and techniques for the enhancement of antenna bandwidth and efficiency. Parts I and II of this report series dealt with tuning and matching network effects on the bandwidth of small antennas, and a review of published techniques both theoretical and experimental, for increasing the bandwidth of small antennas. A small antenna is defined as one whose largest linear dimension is $<0.1\lambda$.

The majority of articles listed in the bibliography come from the IEEE Transactions on Antennas and Propagation for the past 25 years or so. The newest articles are as recent as June 1977. Pertinent reports and papers from other sources are also listed, and can be easily obtained. A small section of the bibliography is devoted to active antennas and techniques. In the present study, active antennas were not examined, but are considered to be an important addition to the art of small broadband antennas.

Every effort has been made to group the articles under their most meaningful classification, but some of the papers should, properly, appear under several headings. This list is not considered to be complete, by any means; but it is believed to be comprehensive enough to give an excellent picture of the state-of-the-art of small, broadband antennas and techniques.

2. ANTENNA BANDWIDTH SUMMARY

A tabular summary of the ideas and techniques investigated during the project and presented in this three-part report series on the performance of low-profile antennas is included in Table I of this report. The antennas and techniques are rated with regard to bandwidth improvements and size. Reference numbers refer to the article or report containing the theoretical, experimental, or numerical data.

3. BIBLIOGRAPHY

A. Antenna Q and Bandwidth (Theoretical)

(1) Carlin, Herbert J., "A New Approach to Gain-Bandwidth Problems," IEEE Trans. Circuits and Systems, Vol. CAS-24, No. 4, Apr 77, pp. 170.

(2) Chen, Wai-Kai, "Explicit Formulas for the Synthesis of Optimum Broad-Band Impedance Matching Networks," IEEE Trans. on Circuits and Systems, Vol. CAS-24, No. 4, Apr 77, pp. 157.

(3) Chessell, C. Ian and Thomas, John A., "A Wide-Band Circularly Polarized Antenna," IEEE Trans. on Antennas and Propagation, Vol. AP-19, No. 6, Nov 71, pp. 736-739.

(4) Fano, R.M., "Theoretical Limitations on the Broadband Matching of Arbitrary Impedances," MIT Research Laboratory of Electronics, Tech Report No. 41, Jan 48.

(5) Fante, Ronald L., "Quality Factor of General Ideal Antenna," IEEE Trans. on Antennas & Propagation, Vol. AP-17, No. 2, Mar 69, pp. 151-155.

(6) Collin, R.E., and Rothschild, S., "Evaluation of Antenna Q," IEEE Trans. on Antennas & Propagation, Jan 64, pp. 23-26.

(7) Kalafus, Rudolph M., "On the Evaluation of Antenna Quality Factors," IEEE Trans. on Antennas & Propagation, Vol. AP-17, No. 6, Nov 69, pp. 729-732.

(8) Vassiliadis, A., and Tanner, R.L., "Evaluating the Impedance Broadbanding Potential of Antennas," IRE Trans. on Antennas & Propagation, Jul 58, pp. 226-231.

(9) Wheeler, Harold A., "Small Antennas," IEEE Trans. on Antennas & Propagation, Vol. AP-23, No. 4, July 1975, p. 462.

(10) Youla, D.C., "A New Theory of Broadband Matching," IEEE Trans. on Circuit Theory, Vol. CT-11, No. 1, Mar 64, p. 30.

B. Summaries of Small Antenna Characteristics

(1) DeSantis, C.M., "Low Profile Antenna Performance Study," Part I: Efficiency and Bandwidth Characteristics, ECOM-4502, Fort Monmouth, June 77.

(2) DeSantis, C.M., "Low Profile Antenna Performance Study," Part II: Broadband Antenna Techniques Survey, ECOM- , Fort Monmouth, Oct 77.

(3) Goubau, G., and F. Schwering, "Proceedings of the ECOM-ARO Workshop on Electrically Small Antennas, Fort Monmouth, Oct 76.

(4) Seeger, John A., Hanson, Robert C., Walters, A.W., "Antennas Miniaturization," Electronic Design, March 4, 1959, p. 63.

(5) Schwering, F., Campbell, D.V., DeSantis, C.M., Czerwinski, W.P., "Low Profile, Hardened VHF Antennas for Armored Vehicles;" Fundamental Limitations, Design Approaches, Required Decisions, Tech Memo, DRSEL-NL-RH-1, Fort Monmouth, NJ, Aug 77.

(6) Walter, C.H., and Newman, E.H., "Electrically Small Antennas," Ohio State University, HDL-TR-041-1, Harry Diamond Labs, Contract No. DAAG-39-72-C-0041, Feb 74.

C. Top-Loaded Monopole Antennas

(1) Bhojwani, Hiro R., and Zelby, Leon W., "Spiral Top-Loaded Antenna: Characteristics and Design," IEEE Trans. on Antennas and Propagation, Vol. 21, No. 3, May 73, 293-298.

(2) Gangi, A.F., Sensiper, S., and Dunn, G.R., "The Characteristics of Electrically Short Umbrella Top-Loaded Antennas," IEEE Trans. on Antennas & Propagation, Vol. AP-13, No. 6, Nov 65, pp. 864-871.

(3) Egashira, Shigeru, and Iwashige, Jiro, "Analysis of Hula-Hoop Antenna and Consideration of its Radiation Resistance," IEEE Transactions on Antennas & Propagation, Sep 75, pp. 709-713.

(4) Reggia, F., "Low-Profile VHF Antennas for Seismic Detection Systems," Harry Diamond Labs, HDL-TR-1635, Jul 73.

(5) Simpson, Ted L., "The Theory of Top-Loaded Antennas: Integral Equations for the Currents," IEEE Trans. on Antennas & Propagation, Vol. AP-1, No. 2, Mar 71, pp. 186-190.

(6) Smith, C.E., and Johnson, E.M., "Performance of Short Antennas," Proceedings of the IRE, Oct 47, pp. 1026.

D. Loop Antennas

(1) Gentry, D.E., "Broadband Impedance Matching of a Loop Antenna," M.S. Thesis, Georgia Institute of Technology, Jun 66.

(2) Skahill, C.E., and Ramsay, J.F., "A Class of Wire Antennas of Low Height," 1963 PTGAP International Symposium, Space Telecommunications, p. 149.

(3) Smith, Glenn S., "Radiation Efficiency of Electrically Small Multiturn Loop Antennas," IEEE Trans. on Antennas & Propagation, Sep 72, pp. 656-657.

E. Electrically Thick Antennas

(1) Bates, R.H.T., and Burrell, G.A., "Towards Faithful Radio Transmission of Very Wide Bandwidth Signals," IEEE Transactions on Antennas & Propagation, Vol. AP-20, No. 6, Nov 72, pp. 684-690.

(2) Chang, David C., "On the Electrically Thick Monopole, Part I: Theoretical Solution," IEEE Trans. on Antennas & Propagation, Vol. AP-16, No. 1, Jan 68, pp. 58-64.

(3) Chang, David C., "On the Electrically Thick Monopole," Part II: Experimental Study IEEE Transactions on Antennas & Propagation, Vol. AP-16, No. 1, Jan 68, pp. 64-71.

(4) Chowdhury, S.K., "Impedance of Multi-element Dipoles," IEEE Trans. on Antennas & Propagation, Sep 71, pp. 682-684.

(5) Foldes, P., "Mathematical and Experimental Studies of a Wide-Band Vertically Polarized Antenna," IRE Trans. on Antennas & Propagation, Sep 60, pp. 469-476.

(6) Imbriale, William A., and Ingerson, Paul G., "On Numerical Convergence of Moment Solutions of Moderately Thick Wire Antennas Using Sinusoidal Basis Functions," IEEE Trans. on Antennas & Propagation, May 73, pp. 363-366.

(7) Kalafus, Rudolph M., "Broadband Dipole Design Using the Method of Moments," IEEE Trans. on Antennas & Propagation, Nov 71, pp. 771-773.

(8) King, Ronald W.P., "Measured Admittances of Electrically Thick Monopoles," IEEE Transactions on Antennas & Propagation, Nov 72, pp. 763-766.

(9) Otto, D.V., "A Note on the Induced EMF Method for Antenna Impedance," IEEE Trans. on Antennas & Propagation, Jan 69, pp. 101-102.

(10) Thowless, E.A., "Dipole Broadband VHF Antenna," Naval Electronics Lab Center, TD-472, 13 Apr 76.

F. <u>Folded Antennas</u>

(1) Fenwick, R.C., "A New Class of Electrically Small Antennas," IEEE Trans. on Antennas & Propagation, May 65, pp. 379-383.

(2) German, J.P., and Brooks, Jr., F.E., "The Effects of the Physical Parameters on the Bandwidth of a Folded Dipole," IRE Trans. on Antennas & Propagation, Apr 58, pp. 186-190.

(3) Giddis, A.R., "A Technique for Matching an Adjustable Folded Monopole Over a 15:1 Frequency Band," IEEE Trans. on Antennas & Propagation, May 64, pp. 370-371.

(4) Harrison, Jr., C.W., and King, R.W., "Folded Dipoles and Loops," IRE Trans. on Antennas & Propagation, Mar 61, pp. 171-187.

(5) Harrison, Jr., W.W., and King, Ronold, "Theory of Coupled Folded Antennas," IRE Transactions on Antennas & Propagation, Mar 60, pp. 131-135.

(6) Leonhard, J., Mattuck, R.D., and Pote, A.J., "Folded Unipole Antennas," IRE Trans. on Antennas & Propagation, Jul 55, pp. 111-116.

(7) Lewis, J.B., "Use of Folded Monopoles in Antenna Arrays," IRE Trans. on Antennas & Propagation, Jul 55, pp. 122-124.

(8) Mushiake, Yasuto, "An Exact Step-Up Impedance-Ratio Chart of a Folded Antenna," IRE Trans. on Antennas & Propagation, Oct 54, p. 63.

(9) Seeley, E.W., "An Experimental Study of the Disk-Loaded Folded Monopole," IRE Trans. on Antennas & Propagation, Jan 56, pp. 27-28.

(10) Vallese, L.M., "A Broadbanded Folded Monopole Antenna," IEEE Trans. on Antennas & Propagation, Jan 72, pp. 92-94.

(11) Wanselow, R.D., and Milligan, D.W., "Broadband Slotted Cone Antenna," IEEE Trans. on Antennas & Propagation, Vol. AP-14, No. 2, Mar 66, pp. 179-182.

G. <u>Passive Loading; Inductive, Capacitive, Parasites</u>

(1) Birchfield, J.L., and Free, W.R., "Dielectrically Loaded Short Antennas," IEEE Trans. on Antennas & Propagation, May 74, pp. 471-472.

(2) Fanson, P.L., and Chen, K.M., "Modification of Antenna Radiating Characteristics with Multi-Impedance Loading," IEEE Trans. on Antennas & Propagation, Sep 73, p. 715.

(3) Hallen´, E., <u>Electromagnetic Theory</u>, John Wiley & Sons, pp. 501-504, 1962.

(4) Hansen, R.C., "Efficiency and Matching Trade-Offs for Inductively Loaded Short Antennas," IEEE Trans. on Communication, Vol. COM-23, No. 4, Apr 75, p. 430.

(5) King, H.E., and Wong, J.L., "An Experimental Study of a Balun-Fed Open-Sleeve Dipole in Front of a Metallic Reflector," IEEE Trans. on Antennas & Propagation, Mar 72, pp. 201-204.

(6) Poggio, A.J., and Mayes, P.E., "Pattern Bandwidth Optimization of the Sleeve Monopole Antenna," IEEE Trans. on Antennas & Propagation, Sep 66, pp. 643-645.

(7) Popovic, B.D., Dragovio, M.B., Paunovic, D.J. S., "Broadband Cylindrical Antenna with Continuous Resistive and Concentrated Capacitive Loading," Electronics Letters, Vol. 11, No. 25/26, 11 Dec 75, p. 611.

(8) Popovic, B.D., Dragovic, M.B., Djordjivic, A.R., "Optimal Broadband Cylindrical Antenna with One and Two Lumped Capacitive Loadings," Electronics Letters, Vol. 11, No. 5, 6 Mar 75, p. 99.

(9) Rao, B.L.J., Ferris, Joseph E. and Zimmerman, Wiley E., "Broadband Characteristics of Cylindrical Antennas with Exponentially Tapered Capacitive Loading," IEEE Transactions on Antennas & Propagation, Vol. AP-17, No. 2, Mar 69, pp. 145-151.

(10) Wong, J.L., and King, Howard E., "A Cavity-Backed Dipole Antenna with Wide-Bandwidth Characteristics," IEEE Trans. on Antennas & Propagation, Sep 73, pp. 725-727.

H. Conjugate and Complementary Structures

(1) Anderson, J.B., and Rasmussen, H.H., "Decoupling and Descattering Networks for Antennas," IEEE Trans. on Antennas & Propagation, Nov 76, p. 841.

(2) Daniel, Jean-Pierre and Terret, C., "Experimental Verification of the Reduced Mutual Coupling Between Appropriate Loads," IEEE Trans. on Antennas & Propagation, Sep 75, pp. 737-739.

(3) Mayes, Paul E., Warren, W.T., and Wiesenmeyer, F.M., "The Monopole Slot: A Small Broadband Unidirectional Antenna," IEEE Trans. on Antennas & Propagation, July 72, pp. 489-493.

(4) Poggio, A.J., "Bandwidth Extension for Dipole Antennas by Conjugate Reactance Loading," IEEE Transactions on Antennas & Propagation, July 71, pp. 544-547.

(5) Schroader, Klaus G., and Soo Hoo, Keith M., "Electrically Small Complementary Pair (ESCP) with Interelement Coupling," IEEE Trans. on Antennas & Propagation, Vol. AP-24, No. 4, July 76, pp. 411-418.

I. Active Antennas

(1) Anderson, A.P., and Dawoud, M.M., "The Performance of Transistor Fed Monopoles in Active Antennas," IEEE Trans. on Antennas & Propagation, Mar 64, pp. 227-233.

(2) Bahr, A.J., "Active Network Techniques for Improving Antenna Performance," Stanford Research Institute, ARO Project No. P13058-EL, Contract No. DAHC04-75-C-0023, 1975-1976.

(3) Beauvais, Michel, Etude De L'Insertion D'un, "Transistor Dans Une Antenne Courte," M.S. Thesis-De L'Universite Laval, Quebec, Canada, Feb 72.

(4) Hodson, Bryan A.B., "A Bibliography of Active Antenna Systems," Royal Aircraft Establishment, Library Bibliography No. 267, Nov 66, AD 807-670.

(5) Copeland, John R., Robertson, William J., and Verstraete, Robert G., "Antennafier Arrays," IEEE Trans. on Antennas & Propagation, Mar 64, pp. 227-233.

(6) Daniel, J.P., Dubost G., Rospars, S., "Transistor-Fed Thick Folded Dipole with Large Bandwidth at Reception," Electronics Letters, Vol. 11, No. 4, Feb 75, p. 90.

(7) Daniel, J.P., Terret, C., "Mutual Coupling Between Antennas-Optimization of Transistor Parameters in Active Antenna Design," IEEE Trans. on Antennas & Propagation, July 75, p. 513.

(8) Dawoud, M.M., and Anderson, A.P., "Calculations Showing the Reduction in the Frequency Dependence of a Two-Element Array Antenna Fed by Microwave Transistors," IEEE Trans. on Antennas & Propagation, July 72, pp. 497-499.

(9) Frost, Albert D., "Parametric Amplifier Antenna," IEEE Trans. on Antennas & Propagation, Mar 64.

(10) Gibson, J.J., Wilson, R.M., "The Mini-State—A Small Television Antenna," RCA Laboratories, Princeton, PE-651, Jan 75.

(11) Lindenmeier, H., "Optimum Bandwidth of Signal-to-Noise Ratio of Receiving Systems with Small Antennas," Archiv Fur Electronik Und Ubertragungstechnik, Band 30, 1976, pp. 358-367.

(12) Maclean, T.S.M., "Resonant Frequency of the Active Loop-Dipole Aerial," Int. J. Electronics, Vol. 29, No. 2, 1970, p. 195.

(13) Maclean, T.S.M., Morrio G., "Short Range Active Transmitting Antenna with Very Large Height Reduction," IEEE Trans. on Antennas & Propagation, Mar 75, p. 286.

(14) Maclean, T.S.M., Ramsdale, P.A., "Signal/Noise Radio for Short Active Integrated Antennas," Electronics Letters, Vol. 11, No. 3, 6 Feb 75, p. 62.

(15) Maclean, T.S.M., Ramsdale, P.A., "Short Active Aerials for Transmission," Int. J. Electronics, Vol. 36, No. 2, 1974, p. 261.

(16) Meinke, Dr. H.H., "Active Aerials," NTZ. 19, No. 12, 1966, p. 697--Library Translation No. 1242, Royal Aircraft Est., Aug 67.

(17) Pelletier, M., Cummins, J.A., Sanzgire, S., "Analysis of Active Antennas by the Method of Moments," Laval University, Quebec, Canada, 1974.

(18) Pelletier, M., "Proprietes Receptrices D'une Antenna Transistorisee Entre 100 et 300 MHz," M.S. Thesis De L'Universite Laval, Quebec, Canada, Oct 73.

(19) Ramsdale, P.A., Maclean, T.S.M., "Active Loop-Dipole Aerials," Proceedings IEE, Vol. 118, No. 12, Dec 71, p. 1698.

(20) Rangole, P.K., Saini, S.P.S., "Transistor Configurations in Integrated Transistor Antennas," The Radio & Electronic Engineer, Vol. 45, No. 3, Mar 75, p. 95.

(21) Snyder, R.E., "A Broadband High Frequency Active Antenna," ECOM Contract DAAB07-73-C-0135, Apr 74, AD-922-501L.

TABLE I

SUMMARY OF BANDWIDTH CHARACTERISTICS

OF VARIOUS "SMALL" ANTENNAS

NO.	ANTENNA TYPE OR TECHNIQUE	BANDWIDTH (IMPEDANCE AND PATTERN)	SIZE HGT X DIA.)	REFERENCE
1	STUB + L-NETWORK	1.16:1 (MIDBAND)	$0.1\lambda \times 0.005\lambda$	B1
2	LOOP + L-NETWORK	1.05:1 (MIDBAND)	$0.1\lambda \times 0.05\lambda$	B1
3	TOP-LOADED STUB + L-NETWORK	∿1.24:1 (MIDBAND)	$\lambda/8 \times \lambda/8$	B2
4	TOP-LOADED, FOLDED + L-NETWORK	∿1.22:1	$0.07\lambda \times 0.1\lambda$	B2, F9
5	ELECTRICALLY THICK MONOPOLE	∿1.8:1	$\lambda/2 \times \lambda/4$	E6
6	MONOPOLE-SLOT	1.3:1	$\lambda/4 \times \frac{3\lambda}{8}$	H3
7	PARASITE-LOADING	1.8:1	$\lambda/2 \times 0.05\lambda$	G5
8	GOUBAU ANTENNA	2:1	$0.05\lambda \times 0.2\lambda$	B3
9	ESCP*	>2.5:1	$\lambda/9 \times \lambda/4$	H5
10	SLOTTED-CONE ANTENNA	>3:1	$\lambda/8 \times 0.44\lambda$	F11
11	HALLEN	>3:1	$\lambda/2 \times 0.03\lambda$	G9

*ESCP ≡ Electrically Small, Complementary Pair